Multi-Camera Array
User's Guide

Tetracam Inc 21601
Devonshire Street Suite 310
Chatsworth,CA 91311 USA

Notices

Documentation Copyright 2010 Tetracam Inc. All rights reserved.
Camera software Copyright 2000-2010 Tetracam Inc.

Printed in the United States of America.

Specifications subject to change.

This software and documentation are copyrighted materials. The making of unauthorized copies is prohibited by law. No part of the software or documentation may be reproduced, transmitted, transcribed, stored in a retrieval system or translated into any human or computer language without the prior written permission of Tetracam, Inc.

Unless otherwise provided by written agreement with Tetracam Inc., this publication is provided “as is” without warranty of any kind, expressed or implied, including, but not limited to, the implied warranties of merchantability or fitness for a particular purpose. Some states do not allow disclaimer of expressed or implied warranties in certain transactions, so this statement may not apply to you.

While reasonable efforts have been made to assure the accuracy of this document, in no event will Tetracam be liable for direct, indirect, special, incidental, or consequential damages resulting from any defect in this publication or the associated software. Tetracam Inc. reserves the right to change this document at any time without obligation to notify anyone.

Trademarks

Windows™ is a registered trademark of Microsoft Corporation.
Photoshop™ is a registered trademark of Adobe Systems.

Other brand or product names are trademarks of their respective holders.

Version 1.2 - Last Modified November 2010

Tetracam Inc 21601
Devonshire Street Suite 310
Chatsworth,CA 91311 USA

Table of Contents

NOTICES 1
TRADEMARKS 1
ABOUT THIS GUIDE 2
QUICK START INSTRUCTIONS 3
UNPACKING THE BOX 4
GETTING STARTED 5
Overview of the MCA System 5
PC System Requirements 6
Software Installation 6
Hardware Installation 7
CMOS Sensor relative Sensitivity 9
CAMERA OPERATIONS 10
GPS OPTION INSTALLATION AND USE 15
HOST SOFTWARE 20
PixelWrench2 20
SensorLink 21
Connecting the camera for Driver Installation 21
USB Disk Configuration: 21
Managing and Processing MCA Images in PixelWrench2 22
Configuring the Camera with Pixelwrench2 23
TYPICAL UTILIZATION PLAN FOR AN MCA CAMERA SYSTEM 25
Mounting the unit 25
Capture Delays for Aerial Photography 25
10 Bit Raw File Format 27
8 Bit Raw File Format 27
10 Bit DCM File Format 28
TETRACAM RS232 SERIAL CONTROL COMMANDS 34
SPECIFICATIONS 35
Basic 35
Image Capture 35
Inputs 35
Outputs 35
SUPPORT INFO 36
Mini MCA Dimensions 37
Std MCA-4 Dimensions 38
Std MCA-6 Dimensions 39
INDEX 40

About This Guide

The Multi-Camera Array User's Guide contains general information about the MCA products covering installation, operation, options and accessories, warranties, and technical support. The information is specific to firmware version 5130 and later – users with earlier firmware should upgrade so that their units conform to the information herein.

The MCA consists of four to twelve digital cameras organized in an array, with discrete filters installed in front of each camera in the array. The primary use of this product is to capture spectroscopic signatures of vegetation, chemicals and geology using a set of filters tailored to the targeted substance.

The purpose of this document is:

1. To guide the user through the installation of the product and its supporting software on its target host system and microscope
2. To describe the basic camera operating procedures
3. To describe the interaction between the camera's interface software and the image editing and archiving software it may be used with.

This document assumes that the user is very familiar with the operation of an IBM compatible personal computer running the Windows Vista, or Windows XP operating system. He should be familiar with the use of USB serial ports and USB disk devices, and in the use of spectroscopic signatures to identify materials of interest.

A PDF version of this manual is supplied on the installation CD.

Quick Start Instructions

Connect the unit to DC power source (The MCA cameras will accept power input between 12 and 14 VDC, and are suitable for most vehicle power supplies)

Install PixelWrench2 before connecting the camera to the computer. This program is needed to manage connections to the camera and to extract useful data from the sets of visible light and NIR images the camera captures.

With the Control Box accessory and a TV display, you can review pictures in the master camera. Press the **SELECT** button and a menu should appear. Select items in the menu using the **UP**, **DOWN** and **SELECT** buttons. These buttons allow you to scroll through the selections. Pressing the **SELECT** button activates a selection. The REVIEW selection gives you access to images in the camera and displays them on the TV Display.

To view your pictures on a computer, you may remove the CF cards and install them in a CF card reader, or plug the camera into the USB interface on your computer.

When plugging the camera into a computer's USB port, Windows will recognize the camera as either an Imaging Device or a USB Mass Storage Device. You can toggle how Windows recognizes the device by holding the **SELECT** button for 5 seconds while powering on the camera. To use the camera with PixelWrench2, the camera must be connected as an Imaging Device. USB Mass Storage Device mode is better suited for simple file transfers between the CF cards and Windows. If the camera is in USB Storage Device mode, "USB DISK" will appear in the viewfinder on a connected display.

From PixelWrench2, you may open previews of the images on the CF card in the camera, and extract them for viewing and analysis. Consult the online manual for PixelWrench2 and the camera for more detailed instructions.

When you are done with the camera, turn it off by disconnecting the power.

Unpacking The Box

This is what you should find in the box.

A Hardened Plastic Camera Case

An MCA or MiniMCA Digital Still Camera

A CDROM with the installation software supporting the camera

Product and Accessory Documentation

A USB interconnection cable

Compact Flash Memory Cards for each camera in the array

An AC Power Adapter and Power input cable

A White Teflon Calibration Plate

Your camera comes with a one-year warranty against defects. You should send in the warranty card to register the camera and qualify for additional software and firmware updates

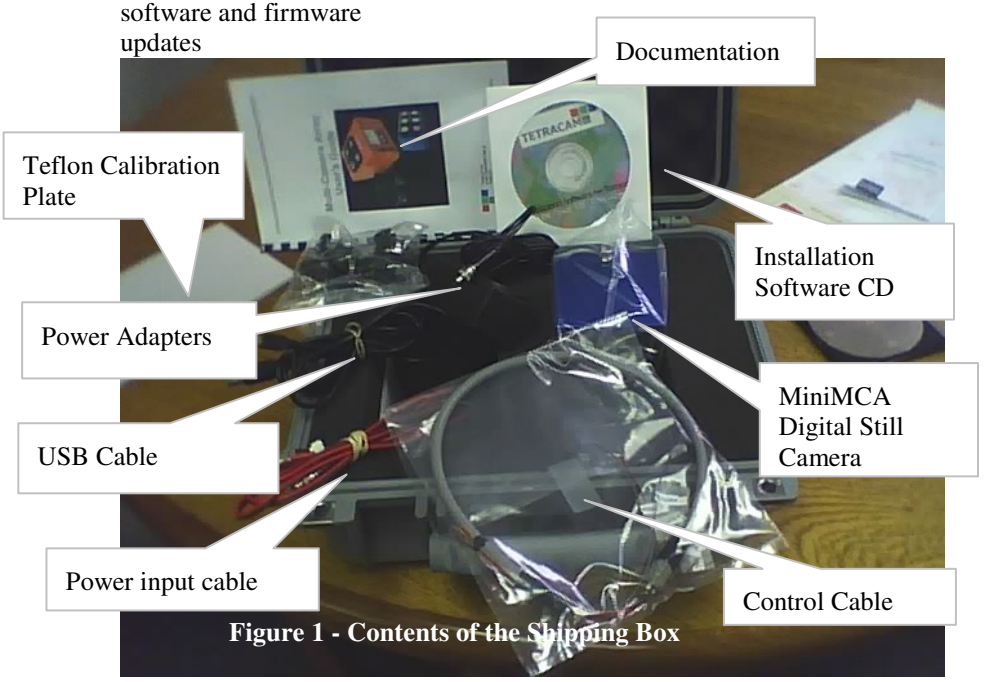


Figure 1 - Contents of the Shipping Box

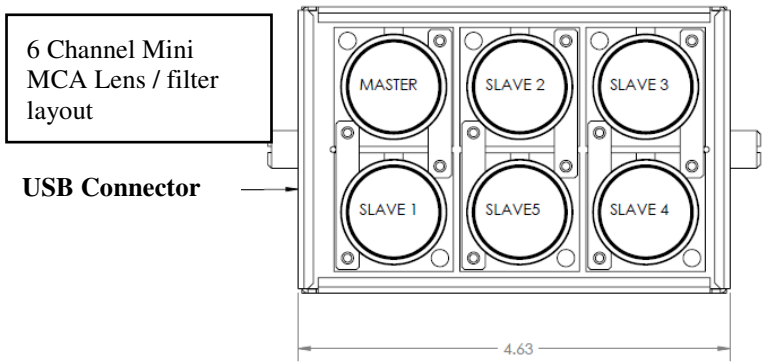
.

Overview of the MCA System

The MCA imaging system consists of a set of digital still cameras compactly packaged and synchronized so they can all take pictures at the same time with only small translation errors between images from unit to unit. These translation errors are automatically corrected by the software supplied with the unit.

One of the cameras in the system is set up as the MASTER camera – the master camera is responsible for synchronizing the other cameras (SLAVES), calculating exposure requirements, and logging GPS geo-referencing information.

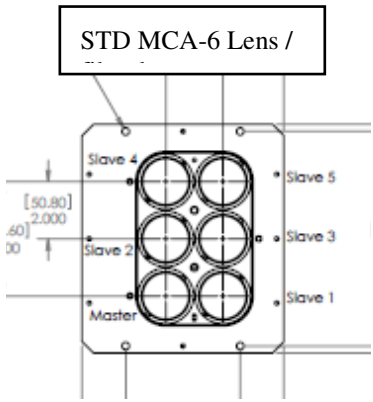
A control connector (and control box accessory) is provided to allow the camera to be triggered in flight, and to provide connection to an external GPS receiver. The control connector also has an output video signal that can be used to monitor the framing of the image. Monitoring can take place remotely, using a commonly available TV transmitter for RC aircraft, or locally, in a manned aircraft, using a TV monitor.



Each camera has its own file system for saving images. In a six-camera system there will be six compact flash cards installed in the unit. Each will have a unique volume ID and naming convention for images that allows the sets of pictures to be separated on the host PC. The software supplied with the camera automatically combines the images into multi-channel TIFF image file for convenient extraction of the data at any time.

Each camera has its own band pass filter – typically a spectroscope filter commercially available from companies like Andover or Sigma. A wide variety of pass filters are available. Bandwidths of 10 nanometers and above will supply acceptable images. Narrower band pass filters (less than 10 nm) can produce some artifacts in the images which must be corrected on the host PC. Band pass filters may be anywhere in the range of 400 nm (blue) to 950 nm (near infrared). The spectral response graph later in this document shows the working range of the sensors. A set of six filters is ordinarily specified at the time of purchase.

Images can be transferred to a host PC by removing and reading the memory cards, or by plugging in a USB cable to the USB Hub controller built into the unit. In a six-channel unit, six separate devices will appear when the unit is connected.



PC System Requirements

Any IBM compatible personal computer with a free USB serial jack can be used to operate and configure the Camera. The unit produces sets of images synchronized for simultaneous capture. The images from the set can be displayed three channels at a time using RGB format for false color rendition. Each RGB rendering is about 3.9 Megabytes. You should select a computer with resources that can support manipulation of images that are this large. Our recommendations for a minimum configuration are:

1 GHz or better processor, Intel or AMD

Windows Vista, Windows 7 or Windows XP operating system

512 megabytes of SDRAM

24 bit color graphics adapter at 1280 by 960 or better resolution

SVGA multi-sync monitor

Large hard disk drive with 10 GBytes or more of free space

The camera can be made to operate on less capable systems, with penalties in speed and convenience.

Software Installation

The software installation CD contains PixelWrench2, the USB stream driver

and a PDF version of the user's manual. To install PW2, run the file Setup.exe located in the PW2 folder. The root folder of the CD also contains the image alignment file for your particular camera. Its name is xxxxxx_global.MCA where xxxxxx represents your camera serial number.

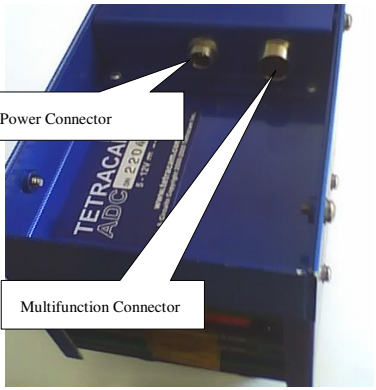
If you have not previously used a digital camera on your system, the Windows operating system may need to install some additional files to support the camera drivers.

If your computer does not have the Microsoft .NET 3.5 framework installed, the PixelWrench2 installer will try to open Microsoft.com and download a file called dotNetfx.exe. This is the installer for .NET 3.5. This file is also on the CD in the root directory where you can run it directly prior to installing PixelWrench2.

Hardware Installation

The MCA and mini MCA run nominally on 12VDC external power. The input has been designed for vehicle electrical systems and can handle input voltages as high as 14 volts. The power connectors are center positive.

The mini MCA and MCA differ primarily in their optical capabilities and weight. The older MCA product supports replaceable C-Mount lenses with variable aperture controls to match filter characteristics. The mini MCA is designed for UAV applications, and weighs only 25% the original MCA weight. It uses smaller miniature lenses with fixed apertures. Filter characteristics are calibrated into the camera firmware in the mini MCA. The optics on the standard MCA are better suited to very narrow bandpass filters.



The MCA camera has a variety of connectors, as itemized in the illustration above. The mini MCA has only a power connector and multifunction control connector available on the external case. All of the signals on separate connectors, including power are available on the multifunction connector. In the discussion of interconnection signals that follows, the signals may be found on the multifunction connector, and also, in the case of the standard MCA, on the separate connectors provided.

Camera Interconnections

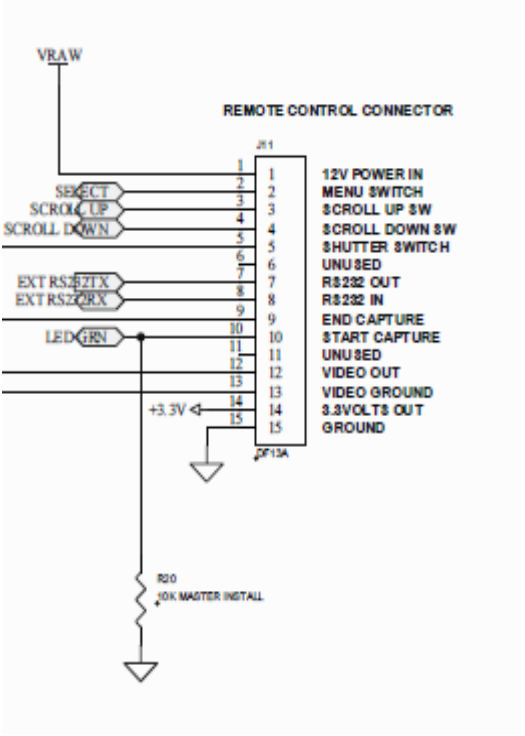
Video Out – configurable by menu for NTSC or PAL

Trigger – Plug the optional external trigger unit into this connector.

Power – The camera requires a 12VDC, center positive polarity supply capable of delivering 0.5 Amps continuous. The supplied wall-plug type supply connects to this jack.

USB – The main USB I/O connector.

Multi I/O – This 16 pin connector is used for external control boxes similar to the Tetracam Videoviewer accessory. The Videoviewer features a 6" LCD display, control buttons for triggering, menu operations and power switching. It has its own power supply, input for an external supply and input for a GPS receiver. The Tetracam external control switch box accessory provides the same functions as the video viewer except for the built in TV. A cable and connector are provided with each unit so that the user may connect his own control inputs via the multifunction connector.



GPS In – A mini-stereo (3 pin) connector allocated for connection of a GPS unit. The camera serial port is configured 4800 – 8 – N –

1, the NMEA 0183 standard configuration. The camera firmware is designed to listen for the NMEA RMC and GGA sentences. If either sentence is found, it is written to the image status string (header) for extraction by application software. The serial port can also be used to control the camera from an external serial interface, using simple text commands described in the Programmers Reference section.

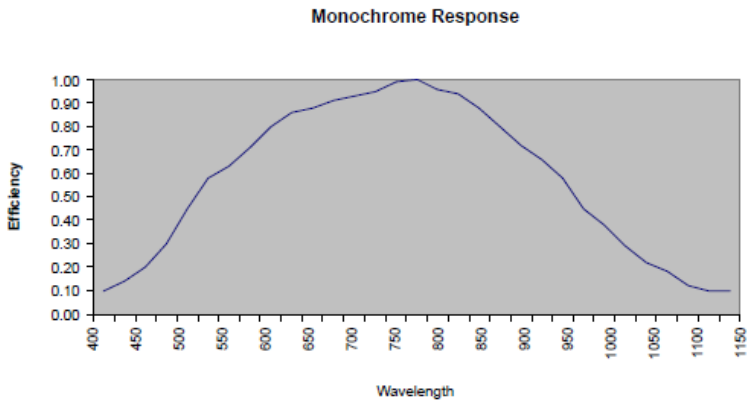
MCA Optics and Filters

All channels of the MCA must be equipped with the same type of lens so the images can be merged with a minimum of error and distortion. Each channel has a receptacle for a standard 1 inch spectrometer filter. The filters can be obtained from a commercial supplier, such as Andover. The unit is supplied with a set of six filters as specified by the customer at the time the unit is ordered.

Changing filters or installing them for the first time requires that the exposure time for each channel by adjusted for the filter characteristics. In the standard MCA, the adjustment can be made by setting the apertures on the lenses, or by entering exposure constants for each channel. In the mini MCA, only the second technique is used, since the apertures in the mini MCA lenses are fixed.

CMOS Sensor relative Sensitivity

The graph below shows the relative efficiency of the sensor for different bands of visible and NIR light.



Compact Flash Cards

The unit can handle compact flash cards up to 2 Gbytes. Since stored images are about 1 megabyte each, a 512 megabyte card is the minimum capacity recommended. A set of 2 GB cards (one per channel) is supplied with the unit.

The unit cannot take pictures without compact flash cards installed.

We recommend that the unit's power be turned off when the compact flash card is replaced. CF cards manufactured by SanDisk have proven the most reliable in our testing of the unit.

The camera is usually operated away from the host computer. If a compact flash memory reader is present on the host computer, the software can extract images directly from the card, without having to connect the camera. This allows the camera to be left in the field, or attached to a vehicle. The CF cards are exchanged to bring the pictures to a host computer.

Large CF Card Issues

When CF cards with capacities in excess of 2 Gigabytes are used they must be formatted as FAT32 cards on the PC. The camera is not capable of initializing CF cards to FAT32 format. Care must be taken to label the volume TTCDISK[1-8], as it comes from the factory, during formatting on the PC. The volume information is used by PixelWrench2 to identify the device as a Tetracam camera, and identify the channels when it appears as a USB Disk. While reliable, use of very large cards with FAT32 format is not recommended unless very long missions with many pictures require it.

Camera Operations

The camera controller is used to setup and manually control the camera. The controller has two connectors on its side: an RCA jack for video out to a TV or monitor and a 3.5mm phone jack for serial RS-232 connection to a GPS receiver. On the bottom of the controller is the 16-pin connection to the camera. At power up, a connected TV or monitor display will illuminate and begin displaying the live viewfinder image. The update rate is controlled by the exposure time and will change if the camera is set to auto-exposure mode.

The Camera Menu System

The camera can be configured from the host computer via the USB connection or by use of the menu selections accessible with the controller and video display.

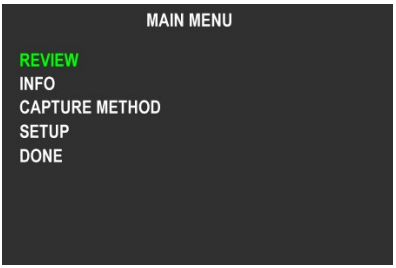
Operation of the menu system uses the three rightmost buttons on the controller: the **SELECT**, **UP** and **DOWN** buttons. To enter the menu system, the **SELECT** button is pressed once. Sub menus appear, or menu items which have values to the right of them.

To select a submenu, use the **UP/DOWN** buttons to move the cursor up or down to the desired submenu entry. Press the **SELECT** key to display the next menu in the tree. If a submenu is not available, (REVIEW cannot be accessed unless pictures have been taken) it will be gray in the display instead of white. The selected entry is hi-lighted in green.

To change a menu item value, press **SELECT** after an item has been selected with the **UP/DOWN** buttons. The value will change color. Use the **UP/DOWN** buttons to select the new value, and **SELECT** again to set the selection.

The menu system can be exited at any time by pressing the **TAKE PIC** button.

MAIN MENU



REVIEW – options for viewing or deleting stored images.

INFO – view battery status, firmware version and storage card space used / free.

CAPTURE METHOD – set file save mode, toggle fixed or auto exposure, toggle single or continuous capture settings, turn on events log.

SETUP – set timeout, display, date / time, and alarm settings, restore defaults, format memory card, select language, configure GPS setting.

REVIEW

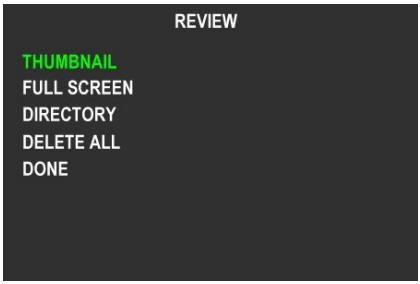
THUMBNAIL – displays four images at once on the screen to quickly scroll through images while viewing them.

FULL SCREEN – show full size images one at a time

DIRECTORY – show a list of saved images

DELETE ALL – erase all images on memory card at once

All images are listed in order from most recent to oldest. Images can be erased one at a time when selected individually.



INFO

Shows the percentage of battery life left (supply voltage on a linear scale between 10 and 15 Volts).

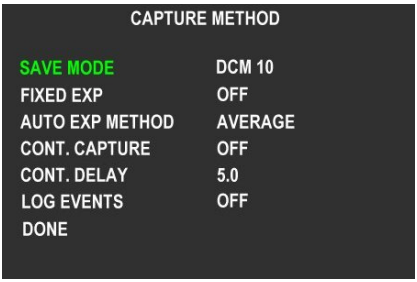
Shows the camera firmware version.

Shows used, free, and total space on the memory card.

CAPTURE METHOD

SAVE MODE – Select DCM 10 lossless image compression to store more images on the available memory card space or select RAW 10 or RAW 8 formats for faster, non-compressed but larger file sizes.

FIXED EXP – Select an exposure time in milliseconds or OFF for auto-exposure mode.



AUTO EXP METHOD – Select PEAK if the subject is the brightest part of

the image, or AVERAGE for all others cases.

CONT CAPTURE – Turn ON to continuously capture images when the capture button is pressed. Turn OFF for normal operation.

CONT DELAY – Sets the amount of time the camera waits before taking another image when in Continuous Capture mode.

LOG EVENTS – Logs image number, time, and GPS position information to a text file.

SETUP

TV – Sets the camera to output NTSC or various PAL standard display feeds.

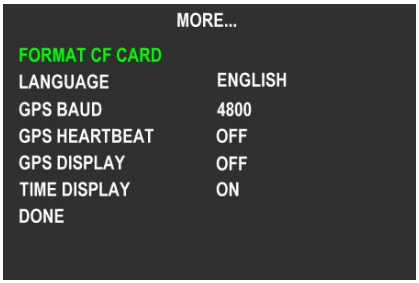
DATE / TIME – Select this to set the time and date for image stamps.

RESTORE DEFAULTS – Select this to restore all factory default settings.

MORE… – More setup options.

MORE…

FORMAT CF CARD – Select this to format a new CF memory card.



GPS BAUD – Set the serial connection data rate between the camera and a GPS receiver.

GPS HEARTBEAT – Turn this feature ON to see the status light quickly flash red each time the camera gets an update from a GPS receiver.

GPS DISPLAY – Turn this feature ON to see the GPS coordinates in the camera's viewfinder screen.

TIME DISPLAY – Toggles the date and time being shown on the viewfinder screen.

Continuous Capture

This mode of operation causes the camera to begin taking pictures when the shutter switch is pressed, and to continue taking pictures until the switch is pressed again. It is the simplest way to operate the camera on a remote aerial vehicle. The rate of capture is controlled by the file format selected, and the additional delay set between pictures.

The highest rate of capture is for the 8 Bit RAW file format, at about 3 seconds per picture. The speed depends in part on the features of the CF card. For users who require more precision, the 10 bit RAW format is the next fastest, requiring about 6 seconds per picture.

The RAW files are quite large – 6 megabytes for the 10 bit format and 3 megabytes for the 8 bit format. Compression (DCM format) cuts the size of the files in half, but takes up to 10 seconds per picture. We therefore think of DCM compressed continuous mode as “low speed”. Besides the smaller file size, another advantage of the DCM format is that the files contain previews which speed up the image access speed using Pixelwrench2.

File Format	**-----Advantages----------**	**----------Disadvantages---------**
RAW 8 bit	Fastest cycle time	Less dynamic range, no embedded previews or image management info
RAW 10 bit	Fastest cycle time with full dynamic range	Big files, no embedded previews or image management info
DCM 10	Smallest file size with full dynamic range	Longest time between pictures (up to 8 seconds)

The table above shows the relative advantages and disadvantages of camera file formats. These apply to all modes of operation.

Configure the camera for SAVE MODE RAW 8 and LOG EVENTS OFF for fastest possible operation. To slow the rate of capture, a delay value, in seconds, can be selected in the CONT DELAY setting. The settings selected in the CAPTURE METHOD menu will only be saved by selecting the SAVE menu item in the SETUP screen.

GPS Option Installation and Use

Your MCA will capture and append the most recent GPS data string to each image as it is taken. The following requirements apply; Your GPS receiver must be configured to output the standard NMEA RMC and/or GGA sentences. The default output protocol for NMEA sentences is 4800 baud, 8 data bits, 1 stop bit, no parity. Your receiver should allow you to configure it for RMC and/or GGA at 4800:8:1:N. If your GPS receiver can be configured for a higher Baud, you should take advantage of the feature, since it will make the GPS data more accurate since less time would be lost transferring the messages. The menu in the camera has an entry for the GPS Baud. There is also an advanced setup screen, accessible via Pixelwrench2 that save a higher baud rate.

The GGA sentence is emitted once per second and contains the following fields:

1. Time UTC
2. Latitude and Longitude
3. Fix quality
4. Number of satellites tracked
5. Horizontal dilution of position
6. Altitude in meters MS
7. Height above MSL

Attach the supplied serial cable to the small serial connector (see the illustration in the Hardware Installation section of this manual). Attach the other end to the serial port of the receiver.

The most recent GPS sentence sent to the camera will be appended to the image data file. You can view the GPS data in the image using Pixelwrench2. The camera firmware also supports an event, or position, logging system that will exactly place the GPS locations versus the time pictures are taken with a resolution of 10 milliseconds.

The camera also has a feature you can turn on in the setup called GPS HEARTBEAT, which will blink the status LED to red and quickly back to green each time it receives a new GPS sentence. This is useful to see that the camera is properly logging GPS data.

There is also a feature called GPS DISPLAY, which can be turned on in the setup menu and will show the last GPS position received.

Event Log File

When LOG EVENTS is set to ON in the CAPTURE METHOD screen, The camera will maintain a file with a record of key events that can be used to accurately position the location at which the picture was taken. Generally, a GPS receiver is connected to the camera serial port that sends $GGA… and $RMC…position strings to the camera.

This feature is used most often with aerial photography, when the GPS point is directly below the camera, so that both the camera and the image are at the same coordinate.

When the option is enabled, the camera creates the file CURRENT.LOG on the CF memory card in root folder. If there is a pre-existing CURRENT.LOG file, the file is moved to the image folder (TTCMCA0 in the case of the MCA master camera) and renamed according to the image numbers that were captured while the camera was last in operation. Only the master camera channel logs GPS data and image events.

For Example:
If images 31, 32, 33, and 34 were captured, there will be event log records for each of those captures in the file. The file is scanned image capture records, and the smallest and largest image numbers found are used to compose a file name. In this case, the file would be renamed to 00310034.LOG. The first four characters of the new file name are the lowest image capture record in the file; the second four letters are the highest image capture record in the file.

A typical Event Log file is shown on the next page. Each line shown is one record in the file, terminated by a newline character and NULL. The NULL characters are hidden, and additional line feeds are added for clarity in the illustration.

Log files can accumulate on the Master camera's CF memory card. If they are not erased from time to time, the resources to capture large numbers of images may not be available. The files can be deleted from the CF card using the conventions of the desktop PC.

Log files are much easier to manage if the camera is set up to operate in the USB Disk mode described earlier. The Log files are not directly accessible from Pixelwrench2 using the stream interface. When the camera shows up as a folder window on the desktop, as it does in USB Disk mode, the moving and deleting files is trivial.

You can use the GPS Distiller tool to manage image and GPS log files. See the PW2 helpfile for more information on how PW2 uses the distilled logfiles to refine the embedded GPS data in each image.

Remember, you can switch the camera between being recognized by Windows as a USB MASS STORAGE DEVICE and an IMAGING DEVICE (USB Disk Mode vs able to connect to PixelWrench2) by holding the SELECT button down for five seconds during power up.

The CLK record is added when the camera powers up. It shows the camera date and

Every Record has a “Ticks” Field that shows the cameras internal clock count of 10 millisecond ticks. The count 104 means that che CLK record was written 1.040 seconds after power on.

CLK 000000104 Date/Time: 10/22/2009 15:15:01

GPS 000002000 00217 $GPRMC,192254.00,A,2942.79012,N,08223.30667,W,000.0,000.0,221009,03.3,W,A*0B

GPS 000002064 00217 $GPRMC,192254.00,A,2942.79012,N,08223.30667,W,000.0,000.0,221009,03.3,W,A*0B
$GPGGA,192255.00,2942.79047,N,08223.30663,W,1,04,2.58,00040,M,-031,M,,*5D

IMG 000003049 00218

GPS 000003102 00218 $GPRMC,192302.00,A,2942.79461,N,08223.30899,W,000.0,

GPS 000003280 00219 $GPRMC,192302.00,A,2942.79461,N,08223.30899,W,000.0,
$GPGGA,192303.00,2942.79517,N,08223.30922,W,1,04,2.58,00062,M,-031,M,,*55

If a GPS is connected, an entry is made each time a GPS update string is received. Different GPS messages are concatenated

When a picture is taken, a record is written showing the system ticks at the end of integration. The camera can only do one thing at a time, so there will always be a system ticks offset between capturing a picture and the GPS messages. The actual position of the camera when the picture is captured can be approximated by interpolating between the two GPS messages using the system ticks.

Reviewing Stored Pictures

Once pictures have been captured and stored on the CF card, the contents of the master camera channel can be inspected in the field using the REVIEW menu option on the TV Display. From the REVIEW menu option, you can see thumbnails or full screen images, information about images, and delete images. Images are listed in order from most recent to oldest.

When an image is selected from the thumbnail screen, or from the list presented in DIRECTORY, information about the file, including the size and date stamp are shown on the screen. When the image is selected from a list provided by the FULLSCREEN entry, the entire image is subsampled and displayed on the TV.

Controlling the Viewfinder

If the image in the TV display produced by the auto exposure logic is brighter or darker than one would like, it can be adjusted with the UP and DOWN buttons on the controller. UP makes the target image brighter, DOWN makes it darker. If the camera is configured for Fixed Exposure (auto-exposure is off) then the up and down buttons will change the exposure time.

Once the viewfinder image is satisfactory, a capture can be initiated with the shutter switch. The Status LED will turn from green to red. Approximately 3 seconds after trigger the camera completes the compression and storage of the image and the Status LED returns to green indicating the camera is ready. If the image format is set to RAW, the cycle is completed much more quickly.

The Calibration Image

An important part of the entire camera and software system is the need to calibrate the software supplied with the camera. Calibration consists of taking an image of the Teflon calibration tag under the same lighting conditions as the images under study. This image is used to teach the application software what the spectral balance of that day's sunlight is.

The ratio of red/NIR or green/NIR is then applied as an offset to the calculation of the various vegetation indexes.

If a calibration image is not taken within an hour or two of pictures in the field, the vegetation index calculations will not be very accurate, and the

pictures may not be useful.

Place the calibration target on the ground, or hold it level with the ground, and photograph it. It need not fill the entire frame and it must not be overexposed. Make sure to avoid a direct reflection of the sun. The sample image on the left is of a properly exposed calibration target.

Later, when the pictures are imported to the host computer, the calibration picture on the CF card will be used to refine the vegetation index calculations using the supplied software applications.

Calibration Target Image

Host Software

The software supplied on the installation CD is made of several major components:

1. An image acquisition and manipulation application, named Pixelwrench2
2. An optional GPS guided camera trigger application named SensorLink
3. A camera interface DLL for extracting images from the camera or CF card, and converting them to Windows DIB format for display.

The goal of this software is to allow the user to extract the Blue/ Green /Red false color images from the captured image set so that band radiation can be visibly displayed regardless of where in the spectrum (NIR / visible) it may lie.

PixelWrench2

PixelWrench2 is a powerful image editing program with several tools specific to multi-spectral images and working with Tetracam ADC and MCA cameras. Open the PW2 folder and run Setup.Exe. This will install PixelWrench2. See the PixelWrench2 online help for more information. PW2 can open MCA proprietary DCM10, RAW10 and RAW8 image files along with several standard image file types (BMP, JPEG, TIF, PNG etc.)

SensorLink

If you purchased the optional SensorLink application you will find a folder by that name on the CDROM included with the camera.

SensorLink is a GPS waypoint triggering application enabling camera triggering at pre-defined waypoints. It uses the same .NET 2.0 framework. Simply run Setup.exe in the SensorLink folder to install it. See the SensorLink online help for more information.

Connecting the camera for Driver Installation

Apply 12VDC with **Center Positive** polarity to the power connector. The small wall plug type power supply shipped with the camera is provided for. Connect the USB cable from a working USB port on the computer to the connector labeled USB on the camera interconnect panel.

On Windows XP systems, the first time the camera is connected to a USB port, Windows will fire the *New Hardware Found* wizard. This will guide you through installation of the camera driver called SvStream.sys. If you plan to operate the camera as a USB Disk, skip to the next section.

Do not let Windows search for the driver. In every case select the option where you specify the name and location of the driver. The driver SvStream.sys and its information file SvStream.inf will be copied to your Windows/System32/Drivers folder when you install either PixelWrench2 or SensorLink. When the driver installation wizard asks for a location, browse to Windows/System32/Drivers.

In both PixelWrench2 and SensorLink, you are required to specify the camera type prior to accessing the camera. In PixelWrench2, on the Camera Toolbar, click the small down arrow on the top button (Status). Select MCA as your camera type. This loads the correct DLL for use with the MCA. See the PixelWrench2 online help file for further specifics on camera communications.

USB Disk Configuration:

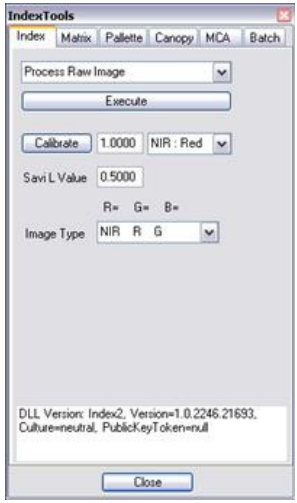
With the introduction of firmware version **5.097** the MCA can be configured to appear as a USB disk drive to the operating system. For Windows Vista, or operating systems other than Microsoft, the camera must be operated as a USB Disk device. To switch to USB Disk mode, the SELECT button must

be held while the camera is powered on with the CF card inserted. This will cause critical files to be created on the CF card, and the unit will subsequently power up in USB Disk mode by default. The files are:
USBDISK.INI
VIEWDATA.BIN
SETTINGS.TXT

Care should be taken when managing the CF Card to preserve these files. They should not be deleted or moved (USBDISK.INI may be deleted to force the camera to NOT be a USB Disk, or created to force the camera to be a USB Disk). When USB Disk mode operation has been selected, it is remembered by the camera until the key files are erased from the CF memory card, or the MENU button is held again during power up to return to the stream interface.

However the camera is configured, it will be recognized by Pixelwrench2 when that application is started. In the original stream mode of operation, Pixelwrench2 is the only way to exchange data with the camera over a USB link. When the unit is configured as a USB Disk, files can be dragged and dropped to and from the camera from any personal computer that has USB disk drivers.

Managing and Processing MCA Images in PixelWrench2



The MCA system writes losslessly compressed image files or RAW files to the CF card for every image. These images carry the extension *.DCM or *.RAW. PixelWrench2 offers all the tools needed for management of MCA images located on the pages of the IndexTools form.

There are four ways to retrieve images from the MCA;

1. Remove the CF card from the camera and copy it's contents to a folder on your computer. The *.DCM and *.RAW files can then be opened directly in PixelWrench2.

2. In PixelWrench2; open the camera toolbar then click *Open Camera*. The camera inventory screen will appear with thumbnails of all the images. Select an image (or images) then click *Load.* The image(s) will be extracted from the camera, color processed using the matrix values entered

and stored by the DLL and displayed on screen as an RGB dib.

3. Power up the camera in USB disk mode and open *.DCM or *.RAW files directly using PW2.

4. Transfer all the files to the PC, and open them with Pixelwrench2 after they are on the hard disk.

Configuring the Camera with Pixelwrench2

Many camera configuration settings can be modified using the Edit Camera Settings dialog accessed from the PW2 Camera Toolbar. To open the Edit Camera Settings dialog, make sure the camera is powered up and connected to USB. Click *Status:MCA* to enable the other toolbar buttons. Click *Setup*. The Setup Camera Attributes dialog will appear. Click *Advanced* and the Edit Camera Settings dialog will appear.

This dialog on the next page contains two columns of edit boxes. Place your cursor over an edit box to view a tooltip describing the setting parameters for that box. In the figure the cursor was placed over the SAVE MODE box. The tooltip shows the possible settings for file save mode. This camera is configured to save in DPCM lossless. Many of the settings boxes do not apply to how the MCA should be configured and there is no reason to change the existing settings.

The list below outlines the settings of interest;

GPS Baud – Sets the baud rate for capture of GPS data. MNEA default is 4800 but some receivers support higher rates.

NTSC PAL State – 0 for NTSC, 1 through 4 for several PAL configurations,

The Edit Camera Setting dialog

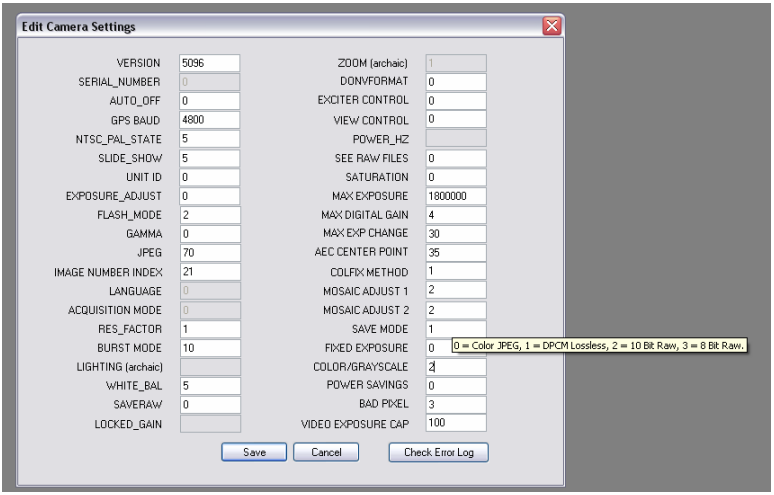


Image Number Index – Sets the number that will be applied to the next image taken, then auto increments as images accumulate. Can be set to any positive value or 0.

Burst Mode – 10 to disable, 11 to set continuous capture, 1 through 5 to set an additional delay between images.

Save Mode – Sets the file format that images are saved in. The MCA should save in DCM, RAW 10 or RAW 8.

Fixed Exposure – Allows presetting a fixed exposure. The value is entered in microseconds. Enter 0 to set the camera to Auto Exposure mode.

Typical Utilization Plan for an MCA camera system

Mounting the unit

The four ¼" holes in the top flange of the standard MCA camera housing are there to accept mounting bolts. In the case of the mini-MCA, the four fasteners that attach the bottom plate to the blue case should be used. It is always advisable to provide vibration isolation between the camera and aircraft. Additionally make sure to ground the camera using to the mount. If the camera is mounted on non-conducting vibration isolators a ground strap should be provided. Dress and restrain all interconnect cables to prevent snagging or undue disturbance by prop blast etc. The MCA camera housing and optics are not weatherproof. If the camera is mounted externally, weather protection should be provided

See the dimensional illustration in the Specification section for additional details.

Capture Delays for Aerial Photography

The simplest way to map large areas is to place the camera in TOGGLED mode (see burst settings), with a BURST DELAY that will insure adequate overlap of the images. Since picture storage is cheap, 30 to 50% overlap is recommended. In order to calculate the delay, the cruise speed of the aircraft and altitude above the ground must be known. For example:

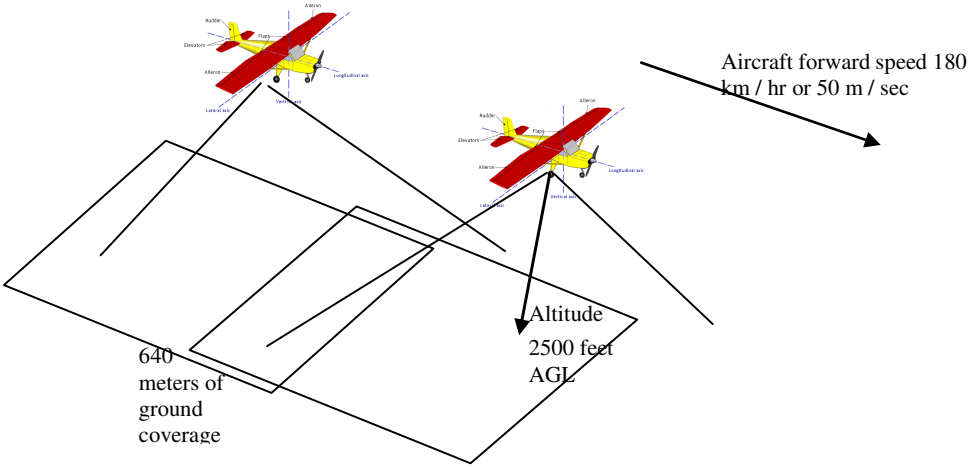
At 2500 feet AGL, the camera captures 1 meter per pixel, or 1.28 kilometers along the long Axis. If we want approximately 30% overlap, we would take pictures every 450 meters. If the aircraft is traveling at 180 Km / hour or 50 m / sec, The time to cover 450 meters is 9 seconds. We would, therefore, set the burst delay in the camera to 9 seconds. In practice, the delay will need to be smaller than this because it takes the camera 2 to 5 seconds to save the picture, depending on the file format. The operator should time the intervals between pictures as displayed on the viewer to verify he has the right picture taking rate.

Increasing the altitude above the ground increases the delay needed while reducing the ground resolution of the images. At 5000 feet AGL, the camera resolution is approximately 2 meters per pixel, which is good enough for many crop surveys. At this altitude the required delay is doubled.

The captured images can be easily assembled into a mosaic by stitching software. We have found that Autopano Pro does a fast and accurate job of

building a mosaic from separate images. We recommend that the images be processed first into the color space needed for analysis - palletized NDVI, or false color NIR, for example. Pixelwrench can do this quickly, using its built in batch functions.

For color temperature calibration, it is convenient to have a 3m X 3m target on the ground painted with a good white latex house paint. The white target can be used to correct color generation for seasonal variations, air pollution, and sun angle.



The camera uses proprietary formats for lossless data storage. DCM files are compressed using differential encoding and Huffman compression. RAW files are the array of captured pixel values with header and trailer information. The exact format of these file in 8 and 10 bit form is shown below.

10 Bit Raw File Format

The RAW file format contains both Header and trailer information. For values greater than 255, two bytes are used in little endian (Intel) configuration for header, trailer and pixel values.

Byte 0-3 Size of raw image in bytes – 32 bit value
Byte 4 Bits per pixel – 10 for this format
Byte 5 Format tag – 16 for RAW files
Bytes 6-7 Pixel Columns – 16 bit value. This is pixels not bytes
Bytes 8-9 Pixel Rows – 16 bit values
Bytes 10-(image size + 10) PIXEL DATA – 16 bit values
Bytes (image size + 10)-(EOF - 28) GPS data. $GGA and $RMC strings
Last 28 Bytes – ASCII exposure string
formatted: "EXPOSURE:%08ld uSeconds\n"

8 Bit Raw File Format

Byte 0-3 Size of raw image in bytes – 32 bit value
Byte 4 Bits per pixel – 8 for this format
Byte 5 Format tag – 16 for RAW files
Bytes 6-7 Pixel Columns – 16 bit value. This is pixels not bytes
Bytes 8-9 Pixel Rows – 16 bit values
Bytes 10-(image size + 10) PIXEL DATA – 8 bit values
Bytes (image size + 10)-(EOF - 28) GPS data. $GGA and $RMC strings
Last 28 Bytes – ASCII exposure string
formatted: "EXPOSURE:%08ld uSeconds\n"

10 Bit DCM File Format

Byte 0-3 Size of image data, GPS data, and various tags in bytes – 32 bit value This value can be used to calculate a pointer to the JPG preview data

Byte 4 Bits per pixel – 10 for this format

Byte 5 Format tag – 16 for RAW files

Bytes 6-7 Pixel Columns – 16 bit value. This is pixels not bytes

Bytes 8-9 Pixel Rows – 16 bit values

Bytes 10-(data size + 10) DATA – 8 bit values

Bytes (data size+10)-EOF JPEG Preview image.

Looking backwards into the data encompassed by the size value in the header there are several fixel length fields, given below with their sizes.

GPS data – 1024 Bytes
Tags for temperature and clock ticks – 16 bytes

We do not recommend trying to process the DCM files with your own code. Contact Tetracam for assistance with sample 'C' source files if reading the DCM file data is absolutely necessary.

Programmer's Reference – C and Visual Basic Support

The interface to the camera is in the library SXGAMCA.DLL This library provides a number of useful camera interface functions. Developers, to incorporate the camera interface into their own programs and plug-ins, can use the interface functions embedded here. The file sxgaMCA.lib is provided in the installation directory to allow static linking to the DLL.

The "include" file loadext.h is available in the installation directory to be made part of any C or C++ program making use of the DLL. It is reprinted in part below. All requests are made by filling the PixRequest structure before the function is called. Sample source files are available from Tetracam to help with the creation of a custom application.

```
typedef struct _PXR
        {
        int requestType;        // ACTION type
        int workSilently;        // do not pop up status or hourglass the cursor
        int imageNumber;         // 0 = last image in camera or file
        char far *fileName;      // 0000:0000 = use camera - Otherwise the file to open
                                 // "" = ask userask user for file name
                                 // "xxxx" = use file xxxx.DCA for reading
        int imageBlue;           // Used for various arguments
        int imageGreen;          // Used for various arguments
        char far *statusString;  // copy camera/image status string to here
                                 // if not 0000:0000
} PixRequest;
```

In Visual Basic a wrapper function is provided which accepts the values passed in as individual variables. It then creates the required structure before calling ProgrammerPlug(). A sample calling sequence from Visual Basic is shown below the interface function definition:

```
TTCAM_API HANDLE VBProgrammerPlug
        (
        int  FAR *requestType,
        int  FAR *workSilently,
        int  FAR *imageNumber,
        char FAR *fileName,
        int  FAR *imageBlue,
        int  FAR *imageGreen,
        char FAR *statusString
        );

/* Here is what a call looks like made from Visual Basic into the DLL:
Declare Function VBProgrammerPlug% Lib "SXGAMCA"
                                        (
                                        requestType%,
                                        workSilently%,
                                        imageNumber%,
                                        fileName as Any,
                                        imageBlue%,
                                        imageGreen%,
                                        statusString as Any
                                        )

For integers, According to the VB manual for version 1.0 or thereabouts,
VB passes, by default, all arguments by reference, (or far pointers,
if your a 'C' programmer. ByVal overrides this by placing the contents
of the variable on the stack, rather than the pointer to the variable.

For strings, It appears the ByVal is the way to point to a string that is
to be modified by the DLL. The examples in the book for calling Windows
APIs that modify strings show a declaration as ByVal. See the chapter
headed "Calling DLL Routines with Specific Data Types" for details.

To pass a NULL pointer to VBProgrammerPlug, use ByVal 0& as the
parameter for fileName or statusString. To pass a pointer to a fixed length
string, use the syntax ByVal StringName$ in the argument list.
*/
The Visual Basic call ends up here after translation of the calling parameters into a PixRequest Structure
TTCAM_API HANDLE PASCAL ProgrammerPlug(PixRequest FAR *);
/*******  Multifunction DLL interface *********************************
```

IMPORTANT
The caller must always use the HOOKUP request before any other reqests are made!!!!
Passed a pointer to a request block this function will perform the
requested action, (see enumerated list, below) and return either the state
of the current hookup, a handle to a DIB image, or the camera or file
status string. After processing any image controlled by the DIB handle
returned, you are responsible for freeing the memory controlled by the
DIB's handle BEFORE calling ProgrammerPlug for another image.
*/

```
enum {HOOKUP = 0,           // Hook up to the camera/file and prepare DLL to
                            // load images in following calls.
                            // if fileName = 0000:0000, use the camera
                            // if fileName = "xxxxx" or "xxxx.xxx", use file
                            // if fileName = "" or "*", prompt user for file name
                            // RETURNED PixRequest values:
                            //      requestType = COLOR or GRAYSCALE
                            //      depending on camera or file type
                            //   imageNumber set to # of images available
                            //
                            //      requestType and imageNumber are both set
                            //    to 0 if a file or camera I/O error occured

                            // If a non-NULL pointer is found in statusString,
                            // the camera or file status string is copied. a ""
                            // is returned if there was an error.

      STAMP = 1,            // return a handle to the STAMP DIB
                            // RETURNED PixRequest values:
                            //   HANDLE to a D)evice I)ndependant B)itap, (DIB)
                            //   requestType = COLOR or GRAYSCALE depending on
                            //   what picture type the stamp represents
                            //   Returns a 0 on error
      GETIMAGE = 2, // standard gray scale image
                            // RETURNED PixRequest values:
                            //   HANDLE to a DIB
                            //   Returns a 0 on error

      CAPTUREBUFFER = 7,    // Returns the camera's image capture buffer
                            // as a DIB. Stretch, sharpen and scale
                            // are also done.
                            // CALL WITH:
                            // imageNumber = image type to return
                            // RETURNED PixRequest values:
                            //   HANDLE to a DIB
                            //   returns NULL on error
```

```
CAMERASTATUS = 8,     // Send the camera status string
                      // RETURNS:
                      //   Camera status string copied to statusString.
                      //   Returns "" on error

IMAGESTATUS = 9,      // Send the imageNumber status string to
                      // RETURNS:
                      //   Image #imageNumber status copied to statuString
                      //   Returns "" on error

SETEXPOSURE = 10, // Send the value in Blue (LSW) and Green (MSW)
                      // to camera as exposure time. 0=automatic,
MULTISELECT = 16,     // Allow Operator to Selecting Multiple Images
                      // CALL WITH:
                      // imageNumber = Number of images pre-selected
                      // statusString= pointer to NULL terminated byte
                      //             array containing the ID numbers of
                      //             images to pre-select, in the order
                      //             desired.
                      //             ARRAY SPACE MUST BE AT LEAST
                      //             57 BYTES!!
                      // imageGreen  = Maximum number of images allowed
                      //             to be selected. If 0, the max
                      //                           is the number of images in the
                      //             file/camera.
                      // imageBlue   = TRUE=Show selection order number
                      //                           in stamp upper left corner.
                      //                           FALSE= No selection Number.
                      // RETURNED PixRequest values:
                      // imageNumber = Number of images selected, or
                      //             zero if none or error
                      // statusString= pointer to NULL terminated byte
                      //             array containing the ID numbers of
                      //             operator selected images in the
                      //             order selected. The array is
                      //             left untouched by errors.
SNAPSHOT = 17,              // Take a picture
                            // CALL WITH:
                            //  Nothing
                            // RETURNED PixRequest values:
                            //       imageNumber = TRUE if connection made
                            //                   FALSE if comm I/O error

FASTSHOT = 18,              // Take a fast snapshot, and return the DIB
                            // CALL WITH:
                            //  imageGreen  = Non-zero uses an on-screen Viewfinder
```

```
GETCOMPRESSEDDATA = 19,      // Return DIB HANDLE points to the
                                    //compressed JPEG or DPCM
                                    // Data from the file in the camera.

            ERASEIMAGES = 22,          // Erases all images in the camera
                                // without prompting the user for confirmation.

      CLOSECAMERAPORT = 25,  // Shuts down communications thru any currently
                                // active port
};
```

Tetracam RS232 Serial Control Commands

Camera serial port command strings consist of a lead-in character, (ESC) a command character (A-Za-z) and a number of numeric arguments. The numeric arguments are strings of Hex Ascii digits either 4 or 8 characters long depending on the magnitude of the value (16 bit or 32 bit). Separators are not required between the argument values, or between the command character and an argument. Spaces can be used as separators if desired.

Below is a table of the command characters currently implemented, and a description of the responses to be expected from the camera. Arguments are shown as <ARG16> or <ARG32> depending on their magnitude (16 or 32 bits).

<ESC>**E**

Erase all Image files stored in the camera's file system.

<ESC>**T**

Take a picture and save the image to CF card memory.

<ESC>**X**<ARG16>

This command controls the camera exposure for the next image with the value in the argument. If the value is 0, the camera performs a light measurement operation, and calculates a reasonable exposure itself. Otherwise, the exposure is set to the number of milliseconds given in the argument.

Specifications

Basic

1.3 megapixel CMOS sensor , 1280 X 1024 X 4, 6, or 12 channels
Replaceable 1” band pass filters for each lens
Image storage to Compact Flash in Tetracam RAW or DCM lossless format.

USB interface
Multi-pin I/O connector for use with Tetracam accessories or user controller.
Sheet metal aluminum enclosure

Image Capture

Capacity: (DCM10) Approx. 0.9MB per image
(RAW10) 2.6MB per image
(RAW8) 1.3MB per image
Rate: Single Shot –(DCM10) Capture to end of cycle: 6 sec.
(RAW10) Capture to ready : 3 sec.
(RAW8) Capture to ready : 1.5 sec.

Inputs

12 – 14 VDC
Current Draw at 12V:

MCA-4	360 ma typical
MCA-6	480 ma typical
MiniMCA-6	450 ma typical
MiniMCA-12	900 ma typical

Rs-232 dedicated to capture of NMEA GPS sentences
External Trigger
USB 1.1 Data Connection

Outputs

Real time NTSC or PAL Video for both viewfinder and menu operations
USB 1.1 Data Connection

Support Info

Your camera comes with a one year warranty against defects or hardware failures. Technical support by phone is available on an intermittent basis.

For Technical Support Call:

818 667 1731 from 8 A.M. to 5 P.M. US Pacific Standard Time

Technical support email:

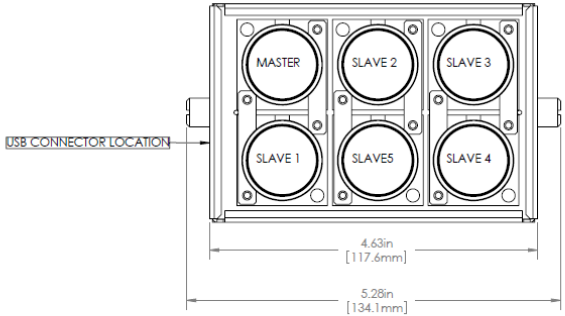
steve@tetracam.com

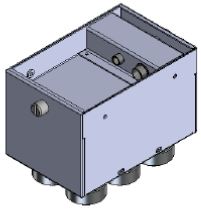
… or visit our website at

www.tetracam.com

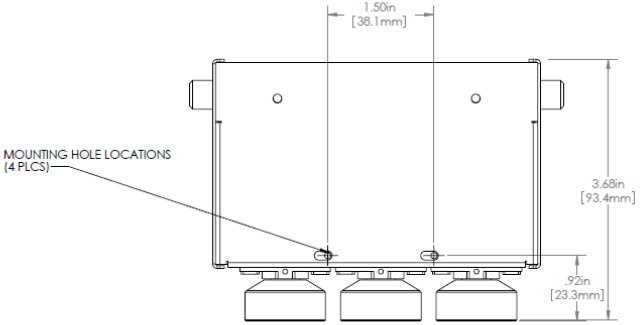
This is the camera we are using

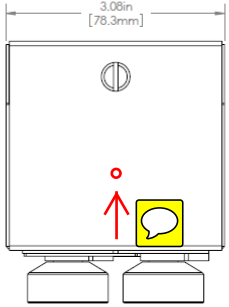
Mini MCA Dimensions





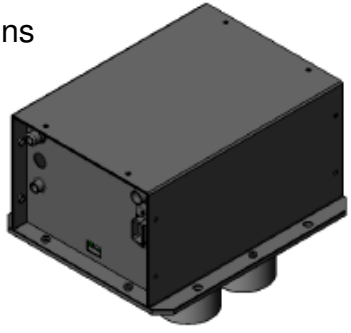
Weight 695 g

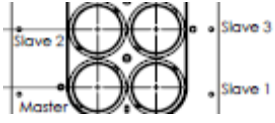


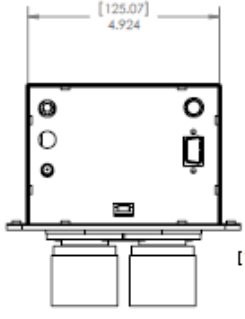


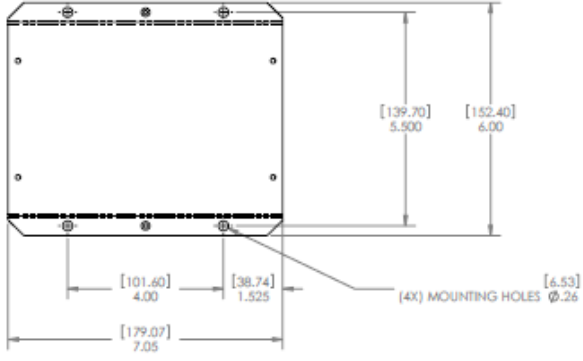
Std MCA-4 Dimensions

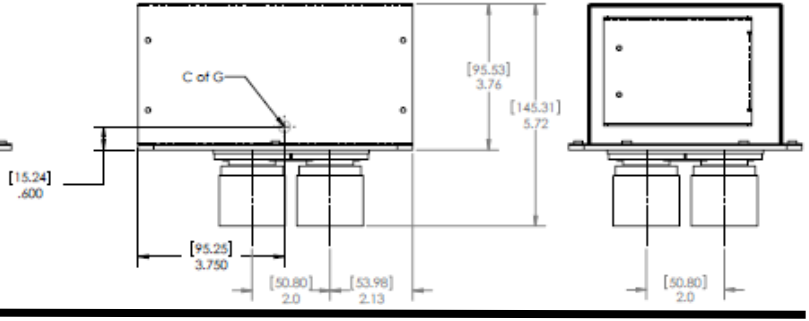
Weight 4 lb.
(1.8 kg) in
4 channel
configuration





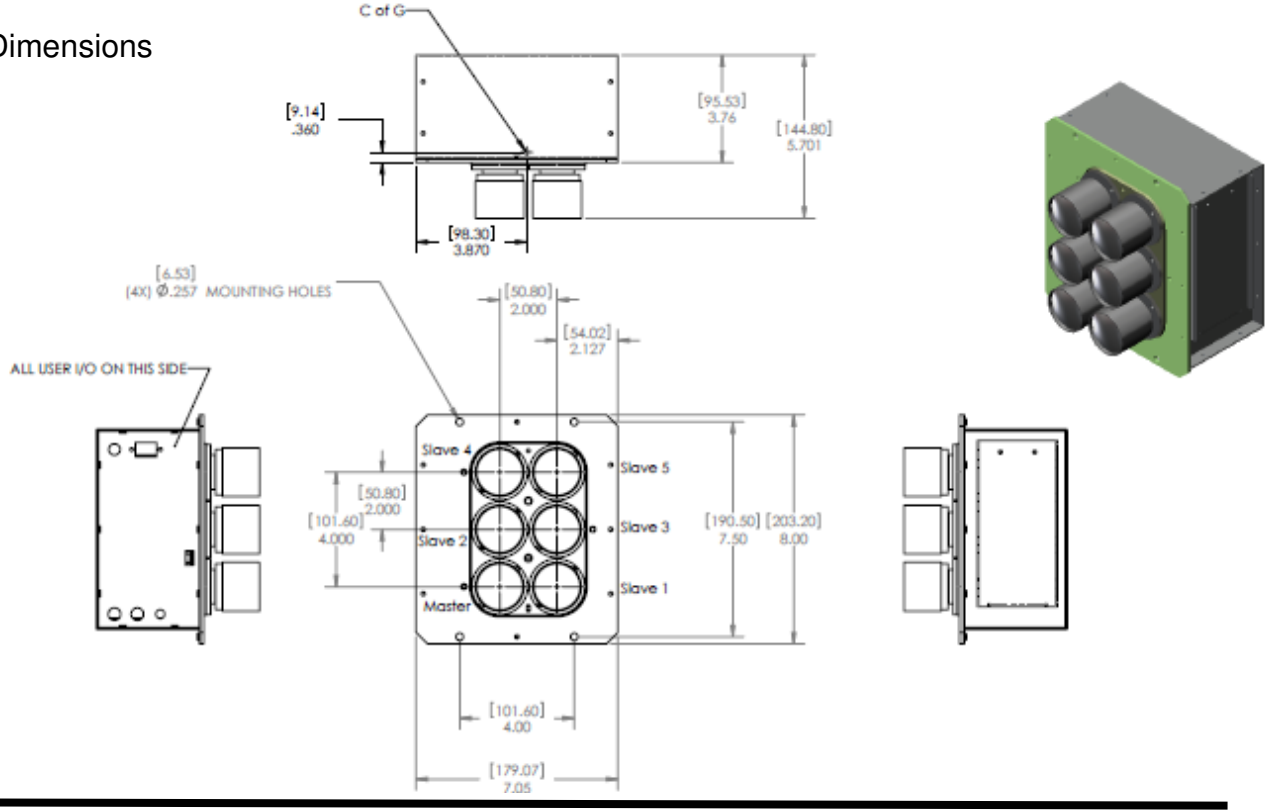






Std MCA-6 Dimensions

Weight 6.25 lb.
(2.85 kg) in
6 channel
configuration



INDEX

A

Accessory, 4
Adobe, 1
All, 1
analysis., 3
APIs, 30
applications., 20
auto-exposure, 10

B

button, 3

C

cable, 4
calculation, 20
calibrate, 19
Calibration, 19
Camera, 1, 2, 4, 6, 10, 23, 32
CAMERASTATUS, 32
CAPTUREBUFFER, 31
CD, 2, 6, 20
CDROM, 4
CF, 3, 10, 20
CF card, 3, 10, 20
CLOSECAMERAPORT, 33
color, 6
compact flash, 10
compression, 19
configuration, 6
Contents, 1
Copyright, 1
cursor, 29

D

DCA, 29
DIB, 20, 31, 32, 33
display, 20
DLL, 20, 29, 30, 31
Documentation, 1
DPCM, 33

E

ERASEIMAGES, 33
exposure, 10, 32

F

FASTSHOT, 32
file, 29, 31, 32, 33
firmware, 4
format, 20

G

GETCOMPRESSEDDATA, 33
GETIMAGE, 31
gray scale, 31

H

Hardware, 7
HOOKUP, 31

I

image,, 31
imageGreen, 29, 30, 32
imageNumber, 29, 30, 31, 32
IMAGESTATUS, 32
imported, 20
index, 20
Index, 40
Information, 4
install, 3
installation, 2, 4, 6, 20, 29
Installation, 7
interface, 2, 3, 20, 29, 30

J

JPEG, 33

L

LCD, 3, 10
LED, 19
library, 29
linking, 29

M

manual, 2, 3, 7, 30
menu, 3, 10
mode, 10
monitor, 6
MULTISELECT, 32
Multi-sync, 6

N

NIR, 19
Notices, 1

P

permission, 1
PixelWrench, 3, 6, 20
PixelWrench,, 3
PixRequest, 29, 30, 31, 32
Power, 4
previews, 3
processing, 31
ProgrammerPlug., 30

R

requestType, 29, 30, 31
Requirements, 6
resolution, 6
review, 3

S

SDRAM, 6
SETEXPOSURE, 32
SNAPSHOT, 32
Software, 6, 20
Specifications, 1
STAMP, 31
States, 1
Status, 19
statusString, 29, 30, 31, 32
storage, 19
string, 29, 30, 31, 32
structure, 29, 30
SVGA, 6
SXGAADC, 29, 30
System, 6, 10

T

Table, 1
tag, 19
technical support, 2
Teflon, 19
translation, 30
TWAIN, 29

U

Unpacking, 4
USB, 2, 3, 4, 6, 10
User, 2

V

value, 32
VB, 30
vegetation, 20
version, 2, 6, 30
Version, 1
viewfinder, 10

W

Warranty, 4
Windows, 1, 2